CHAPTER 2 – DIGITAL TELEVISION – (19 pages)

(of six chapters)

DIGITAL TELEVISION BROADCASTING:

Perspectives on the Future

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A minor thesis for Partial Fulfilment of the Requirements for the Degree
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CHAPTER TWO

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2.1 Introduction to Television Transmission Formats

International terrestrial broadcasting standards are currently in a state of transition as many countries begin the painstaking move to digital television broadcasting (DTV). Unfortunately, the opportunity to overcome the transmission incompatibilities of analogue broadcasting has to a large extent been squandered with a new set of competing standards. As a consequence, the international television sector will not only have to reconcile the previous three analogue formats of PAL, SECAM, and NTSC, but an additional three digital transmission formats. This state of affairs is further complicated by the necessity of 'simulcasting', which entails the broadcasting of both analogue and digital signals of the same programs, simultaneously. Governments around the world have adopted this approach as the safest transition route from analogue to digital, allowing consumers to make the transition over a period of years, and thus ensuring viewers are not disadvantaged in the process.

As this transition period is likely to continue over a number of years, coupled with the fact that most nations have yet to even consider the move to DTV, the old analogue transmission formats will remain relevant for some years to come. Moreover, 50 years of analogue television will live on in content archives indefinitely, unless significant expense is incurred to transfer this analogue material to digital. For these reasons, and to assist in understanding DTV, it is necessary to briefly cover the various analogue transmission formats currently used around the globe.

2.2 Analogue Terrestrial Broadcast Standards

Essentially there are three main terrestrial analogue broadcast formats in the world, all of which are more or less incompatible with one another. While the European PAL and SECAM are somewhat compatible – in that they have the same frame rate and line structure – the American NTSC has a completely different line/frame rate structure and is entirely incompatible.

The difference in frame rates/line structure largely has its roots in the very early television sets, which used the mains power frequency to sync the field timing reference as each new image was received by the set. This resulted in field frequencies of 60Hz in countries with a 60Hz power frequency cycle (110 volts, 60Hz), and 50Hz in 220/240 volt countries. The 50Hz and 60Hz field frequencies spawned frame rates of 25 and 30 (29.97 to be exact) respectively.

With a video bandwidth of 4.2MHz, the American NTSC (National Televisions Systems Committee) is capable of resolving 525 lines per frame, while the slightly higher 5.0 MHz video bandwidth of PAL (Phase Alternating Line) and SECAM (Sequential Couleur Avec Memoire) produces 625 lines per frame. Moreover, apart from the greater line resolution of PAL/SECAM, the colour processing characteristics of these two standards out performs NTSC in broadcast situations, resulting in higher quality images.

2.2.1 Aspect Ratios

However, the three competing formats do have a number of factors in common, the first of which is a 4:3 picture aspect ratio, or the ratio of the width to the height. In this case, the picture is one unit wider than it is square. This aspect ratio was not arbitrarily chosen at the onset of television, but was rather a deliberate decision to approximately match the aspect ratio of most 35mm theatrical films shot in the 1930's, 40's and 50's. Once the popularity of television began to erode the economic viability of cinema, film producers began shooting their films in wider, more panoramic aspect ratios in an attempt to attract people back to cinemas.

2.2.2 Bandwidth

The second characteristic that these standards have in common is an affinity of bandwidth, and lots of it. A continuous wave signal, analogue terrestrial broadcast consumes close to the entire allocated television broadcast bandwidth, which is usually separated into an equal number of channels. In Australia the television bandwidth channel is 7 MHz wide, while it is 8 MHz in Europe and 6 MHz in the United States. In other words, each television station has only enough bandwidth to broadcast one analogue signal. Until the advent of digital, there has been no way around this bandwidth squeeze. Moreover, each of the standards is locked in; that is, there is only one resolution capable of being transmitted, received and displayed on the set.

2.2.3 Interlacing

The final factor that these analogue standards have in common is that they all employ interlaced scanning. Interlaced scanning is a form of analogue compression, designed to present the eye with 50/60 frames per second, although each frame (field) contains only half the information of a full frame. Interlacing works by scanning every odd line on the screen, followed by every even line in the second scan. Reducing bandwidth, this form of scanning enabled earlier television sets to adequately display the images as they entered the receiver. However, according to Dr. William Glenn of the Florida Atlantic University Imaging Systems Laboratory, image flicker, especially on larger screens, is a major drawback of interlace scanning, resulting a reduction in perceived picture resolution (qtd in "Birkmaier", 1999, part 7).

Progressive scanning is a newer form of scanning that has been adopted by the computer industry, and is now emerging in digital television standards. Instead of showing half of the image over two fields, progressive scanning displays every line in one frame, increasing resolution, reducing flicker, but also increasing bandwidth – which is less of a problem with digital compression systems. Glenn states that "….progressive scan does not have interline flicker, a visible line structure, or line crawl. Consequently, the vertical resolution is limited only by the frame sampling structure." (Ibid.) This has led some to claim that the higher line structure interlaced formats, such as 1080i, actually have inferior perceived resolution than the lower line structure progressive scanned formats, such as 720p. However, it is important to recognise that 1080i has twice the pixel resolution of 720p, resulting in greater spatial resolution when the picture is still or contains little motion. All things being equal, it can be said that a progressive scan image has higher resolution than an interlaced image. However, for this to be true, a progressive format would need to support an equal line structure to 1080i, as well as an equal temporal rate of 50/60 frames per second. At present, such a bandwidth hungry format is not supported. While the interlace versus progressive scanning issue is irrelevant for analogue transmission formats, it becomes important with digital television formats, which include both interlaced and progressive scan modes.

2.3 Digital Television Transmission Standards

The concept of digital television is really a paradigm shift in broadcasting, a radical departure from the analogue world of acquisition and delivery, where the entire chain of creation, transmission and reception was completely locked to the prevailing broadcast standard, be that PAL, SECAM or NTSC. This meant a fixed frame rate (25 or 30 frames per second), fixed line resolution (625/525) and fixed bandwidth. In short, a robust, but highly inflexible, high bandwidth consuming set of standards. PAL, SECAM and NTSC acquisition and post-production equipment will be replaced by digital standards that are internationally compatible.

While there are three competing transmission standards for digital television – DVB, ATSC and ISDB – television program makers will for the first time share a set of common acquisition and post production digital formats, enabling seamless program interchange and consigning the absurd program incompatibility problems of the analogue systems to history.

The flexibility of digital transmission lies in the fact that its MPEG-2 compression standard is a series of binary digits, transmitted as a bit stream to television receivers, which in turn convert the compressed digital information to images and sound. Employing MPEG-2 compression allows a substantial reduction in bandwidth, achieved by only transmitting the data necessary to show a change in the picture, while discarding redundant information (DCITA, 2000). While the 7 MHz pipe, or bandwidth spectrum, currently allocated to analogue transmission in Australia can only carry a single standard definition television (SDTV) program, the same 7 MHz spectrum ultilising digital transmission is capable of broadcasting "…up to six services using SDTV, or as many as ten services with lesser definition formatting." (Ibid.) What this means is that broadcasters are presented with the potential to utilise their allocated spectrum in a far more flexible way, either choosing to broadcast one ultra high resolution picture (HDTV), a number of standard definition programs simultaneously, datacast, or mixture of all of the above. The only restriction is that they must not exceed the maximum 7MHz pipe, which equates to a total data rate of about 20 Mbits per second.

Unlike the analogue transmission standards, which were of a fixed bandwidth, the data rate of individual programs within the 20 Mbps pipe will vary according to the nature of the program. For example, standard definition drama or ‘talking heads’ may utilise 4 to 5 Mbps of data, while fast moving sports may consume as much as 10 Mbps of data (Ibid.). This would indicate that in this case, the broadcaster must choose between four drama/talking heads programs, or two fast moving sports programs. Alternatively, the broadcaster may elect to broadcast two drama programs, one in HDTV and one in SDTV. Again, it is important to realise that the data rate of each program will depend on the degree to which its pictures change from one frame to the next, and the format resolution. Moreover, information, e-commerce applications and web pages may also be ‘datacast’ at 1 to 2 Mbps. MPEG-2’s ability to vary the bit rate is not dissimilar to video on the World Wide Web, where streaming video can be accessed at a number of different data rates, based on the user’s optimum modem speed.

Once the broadcaster has decided on how to best utilise its bandwidth at any given time, the various MPEG-2 program streams are multiplexed into one bit stream for transmission on a single frequency, where they are ‘unpacked’ by the television receiver or set-top box. While acquisition and program creation will now be internationally compatible, broadcast transmission and television reception will still be incompatible, based on either European DVB, American ATSC, or the Japanese ISDB.

2.4 DVB, ATSC and ISDB

After extensive testing by the Australian Digital Terrestrial Television Broadcasting Selection Panel in 1997, the Australian Government accepted its recommendation that the European DVB-T digital transmission standard be adopted for Australian digital broadcasting. DVB is a family of compatible broadcasting standards dedicated to terrestrial, cable and satellite digital transmissions. It consists of DVB-T for terrestrial broadcasts, DVB-S for satellite broadcasts, and DVB-C for cable transmissions (DVB, 1998). Both the European DVB and the American ATSC use the standard MPEG-2 data container to carry all video, audio and multimedia data. At the time, the Australian version of DVB-T was slightly different, as it supported both the internationally accepted MPEG Audio standard, as well as the American Dolby Digital AC-3 surround sound specification. Moreover, the Australian DVB-T specification also supported High Definition Television transmission.

While the DVB and ATSC systems both support a set of common SDTV and HDTV formats, where they purportedly differ is in their signal robustness, which is largely a function of the frequency modulation used within each system. DVB employs COFDM (Coded Orthogonal Frequency Division Multiplex) modulation, a unique method for constructing single frequency networks, which essentially permits the transmission of signals on the same frequency, even if adjacent transmitters are broadcasting the same signals. Conversely, the American ATSC system employs 8-VSB modulation, a system that requires adjacent transmitters to broadcast on another frequency. As a consequence, COFDM modulation results in greater frequency efficiency, while also resisting multipath interference, or ghosting, which is often problematic for non-single frequency networks.

The ability to tolerate multipath transmission is also critical to successful mobile television reception, such as moving cars, buses and other craft. According to tests conducted by the DVB organisation, mobile reception has been successfully received at speeds of up to 275 km/h on highways, as well as in moving trams through dense city centres (Ibid.). According to the DVB organisation,

> "…with 8-VSB (ATSC) the only possible service is fixed reception and recent tests in the USA have shown that it won't even replicate the existing NTSC service….The inability to handle multipath make 8-VSB difficult to use in the portable environment. Fixed portable is a possibility if the correct spot is found where everything works. However, walking portable is not possible. DVB-T on the other hand has already been shown to work in this situation…..DVB-T is already being used in Singapore for the delivery of Television to buses." (DVB, ?)

With wireless mobile television reception a possible gold mine for broadcasters, given that Internet, cable and satellite technologies face great challenges in this arena, selecting a transmission standard conducive to mobile reception is of paramount importance. Many independent comparative tests have also found the DVB-T system to be superior. John Crane, the TEN Network Engineer for Digital Development, was on the FACTS evaluation panel when the standards were tested in 1997, he states;

> "…When we were testing the American ATSC system against DVB, we found that ATSC had a better impulse noise rejection but the reflection and multipath rejection was superior in DVB…..We looked at mobile reception, how it worked in a car ignition noise environment, how it worked with ghosts and what formats were available within it…..Overall it was plain that the choice should be DVB as it was superior." (Crane, 2002).

Even in the United States, many industry experts are calling for the 8-VSB modulation to be replaced with COFDM, especially after tests by Sinclair Broadcasting in Baltimore found that 8-VSB was not only inferior to COFDM, but was even inferior to NTSC (Birkmaier, 1999). So why did the ATSC go down the 8-VSB route? Essentially because the ATSC system was optimised for HDTV and fixed receivers with directional outdoor antennas. At the time, little thought was given to the impending wireless world of portable communications and data delivery. While many American broadcasters would like to expand their services to wireless devices, they will find opposition to COFDM in some powerful American component manufacturers committed to their own systems. It was these large broadcast equipment manufacturers that developed the ATSC standard, a collection of companies known as the digital television Grand Alliance. It is unlikely that they, or the US Government, is prepared to concede defeat to the Europeans – at stake is a billion dollar digital transmission/receiver manufacturing industry. This is compounded by US Congress suspicions that the US broadcasters desire a move to COFDM in order to "…compete with the telecommunications companies in the lucrative new markets for wireless data services. It is clear that this is not a franchise that the politicians are going to give to the broadcasters." (Birkmaier, 2000)

While the US sticks doggedly to their 8-VSB ATSC transmission standard, DVB-T is quietly becoming the global transmission standard. In the light of Australia's comparative test of DVB-T and ATSC, many countries that had committed, or considered the American standard, conducted their own comparative tests to arrive at the same conclusions. The most recent of these is Taiwan, which switched from ATSC to DVB-T in 2001. Today, only the US, Canada and Korea have stood by the ATSC standard, while Europe, Australia, South America, South East Asia, India and China have adopted, or are likely to adopt, the DVB-T (DVB, 2002). With these huge markets adopting DVB-T, the enormous economies of scale will see digital receivers, set-top boxes and HDTV receivers in the DVB-T format substantially fall in cost once production reaches critical mass.

While the Europeans and Americans battle it out, the Japanese have developed their own system for digital television, called ISDB (Integrated Services Digital Broadcasting). Essentially ISDB is a hybrid of both DVB and ATSC, an attempt to incorporate the strengths of both systems. However, while the Japanese format has tested equal to, or slightly better than DVB-T, it is unlikely to be adopted outside of Japan, given the lack of economies of scale in producing the necessary transmission/receiver equipment.

[Update 5/5/03. As the world's largest manufacturer of television sets, China has been the focus of an intense lobbying campaign by representatives of both the ATSC and DVB systems. While China has adopted DVB-S for satellite transmissions, and is likely to adopt DVB-C for cable, the Americans and Europeans were surprised by the 2001 announcement that China would develop its own independent terrestrial DTV standard. According to the People's Daily Online, the Chinese DTV terrestrial standard would borrow heavily from telecommunication schemes to create a system capable of "….not only standard and high definition TV broadcasting but also for future data services and even cellular phone applications (People's Daily, 2003)". According to the article, the Chinese decision was motivated by concerns about current DTV transmission problems, especially 8-VSB modulated ATSC, as well as a desire to seize an opportunity to create their own system (Ibid.) With patent rights and royalties running as high as $20 per television set, China is not the only country considering developing their own DTV-T standard. Brazil, Argentina, Chile and India are discussing the prospect of working with China to develop a 'non-aligned' DTV standard, uniquely created for the needs of the developing world.

The hitherto superiority of DVB's mobile performance was recently challenged by an ATSC mobile demonstration at the NAB 2003 conference. Utilizing Microsoft's Windows Media 9 compression technology, it is now possible to broadcast ATSC to a range of mobile devices - televisions, PCs and other mobile devices – and at a bit rate two thirds less than that of MPEG-2. Such a remarkably reduced bit rate would make it possible to transmit HDTV at under 5Mbps and SDTV at under 1.5 Mbps. Windows Media 9's IP datacasting of broadcast television can be employed within the MPEG-2 structures of DTV, including both ATSC and DVB systems, and a number of set-top box manufacturers have already agreed to support Windows Media 9. A number of cable TV companies have committed to employing WM9 to deliver video content, while the technology can also be employed to deliver content via broadband, satellite, DVD and other physical media. As evidenced by Windows Media 9, HDTV may not remain bandwidth hungry.]

2.5 The Viewing Experience of Digital Television

Apart from freeing up valuable frequency spectrum, which can be auctioned off by governments to provide other services, the move to digital television is mainly concerned with improving the viewing experience of television, a medium largely unaltered since the adoption of colour in the early 1970's. In this section, the author will briefly outline some of the features of the digital television viewing experience, along with accompanying issues that potentially impact on DTV content creation.

2.5.1 Improved Imagery

It is important to recognise that digital television is not necessarily High Definition television, in fact, HDTV has only been adopted in the United States, Canada, Australia and Japan. In Europe, where DTV is the most widespread, HDTV has not been adopted at all. Therefore, is it correct to view HDTV as a subset of DTV, a set of higher resolutions that require a commitment from regulators, broadcasters and set manufacturers before it can be transmitted. As a result, digital television usually expresses itself in the standard definition mode (SDTV), with a picture quality equivalent to the 625 (575 active) analogue PAL signal currently broadcast in Australia and Europe. In the United States, it will be commensurate with the 525 (480 active) lines of the NTSC signal.

However, despite possessing the same line resolution of analogue television, digital SDTV is capable of producing better quality images in the television receiver. This is explained by the very nature of the digital signal itself. Unlike continuous wave analogue signals, which are reproduced by the television receiver unfaithfully, suffering from interference, ghosting and diminishing signal strength, digital signals are either 'on' or 'off' – either reproducing an exact copy in the receiver, or not producing an image at all. The result is dramatically clearer pictures for television receivers in built up areas or uneven terrain. This becomes even more important for mobile wireless devices.

2.5.2 Widescreen Television

Widescreen television gained its impetus from the cinema, where film-makers in the 1950's abandoned the 4:3 aspect ratio of analogue television in an attempt to distinguish the cinema from the television. It is widely accepted that a widescreen aspect ratio results in a greater field of view, and which, when close to the audience, allows the viewer to feel more immersed in the action. The advent of digital television was seen as opportunity to spurn the more box like aspect ratio of the first 50 years of television, for a more cinematic widecreen aspect ratio. The new internationally accepted aspect ratio for television is 16:9, translated into a picture width that is 16 units wide for every 9 units high. In cinematic terms, 16:9 is called 1.78:1, and with most feature films being shot in 1.85:1, a 1.78:1 (16:9) aspect ratio for DTV is seen as a fairly close match. As a consequence, most feature films can be broadcast on DTV with minimal cropping of the original image, which in the traditional 4:3 analogue television picture could be as much as two thirds of the entire picture.

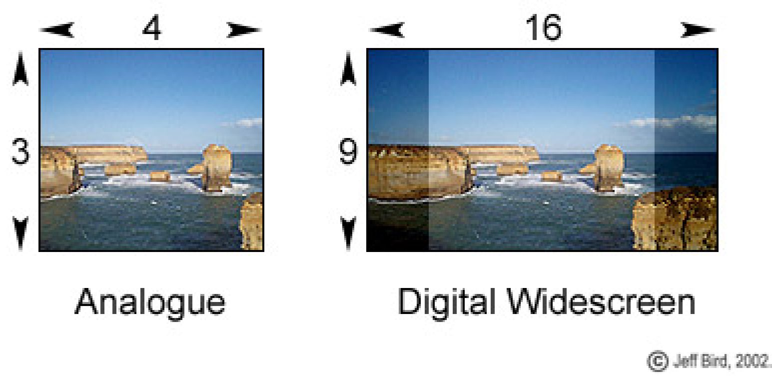

Figure 2.1: 4:3 and 16:9 aspect ratios

With a 4:3 analogue aspect ratio, broadcasters and filmmakers have lived with a painful choice when it came to television transmission of movies. The purest approach, common in Europe, and in Australia on SBS, is to 'letterbox' the image by placing black masking at the top and bottom of the screen. However, while this approach allowed viewers to see the movie in its intended aspect ratio, it severely reduced the image area on the screen, a problem acerbated by small television screens. The other approach, common in the United States and on Australian commercial stations, is to employ a technique known as pan and scan. This method essentially zooms in on the movie to display a full 4:3 aspect ratio, resulting in significant image loss at the sides of the original film. To retain the integrity of the story, or even to avoid losing the characters off the screen, decisions are made about what is the most important part of the screen, and the picture is panned accordingly. For instance, a character may walk from the left side of the frame, which is out of shot on the 4:3 aspect ratio, right across the screen to disappear on the other side. In this case, the picture would be panned as the character moved from one side to the other, and while this would keep them in shot, it is a less than satisfactory way of maintaining the director's original cinematic vision.

However, while the new 16:9 aspect ratio will become the standard for program creation and television broadcast the world over, broadcasters will now live with the 4:3 legacy, given that most non-cinema television programs have been shot and edited in the old 4:3 format. This will necessitate the reverse of the previous problem, requiring broadcasters to either display 4:3 content in black side bars known as 'pillarboxes', or artificially create a 16:9 image by zooming or stretching the 4:3 image. Obviously, once widescreen content becomes the rule, any programs shot in 4:3 and broadcast in pillarboxes, or stretched, will be less appealing to audiences. It is for this reason that producers with foresight have for some years shot their 4:3 programs on film, ensuring that their expensive content would survive in a 16:9 world.

With a wider image area, the move to the 16:9 aspect ratio will impact on production processes, in particular equipment, cameras, lighting, sets, editing, captioning, graphics and even stage movements. On a purely practical level, the wider screen area may reveal the edges of sets, lighting equipment, microphones and other cameras. Sets, floor plans, and deeply ingrained production habits will have to be adapted to a 16:9 world. And while the widescreen image may be ideal for most sports, allowing more of the field to be included within shot, some sports will find 16:9 somewhat awkward, as Randall Paris Dark acknowledges in his paper titled, 'Framing for Two Worlds',

> "However, with every advantage there are also limitations. Think tennis. The primary camera position is behind the tennis player, where the 4:3 frame works perfectly. The 16:9 frame fights that angle, there is too much air on each side of the court from that camera position. Pan and scan from the end camera would be next to impossible. With a few sports, new camera positions will have to be experimented with and we will have to find new and compelling ways of covering sporting events." (qtd in "Birkmaier and Pescatore", 2000, chapter 4)

However, adapting to the 16:9 aspect ratio is further complicated by need to ensure that images also convey meaning on legacy 4:3 ratio televisions. Jane Eakin, Promotions Producer at the TEN Network explains the dilemma,

> "There are two issues that we face almost daily. The first is how to create attractive widescreen images that have their essential message in the 4:3 'centre cut' area. The other is to convert material that is widescreen and hasn't been shot with a 'protected' 4:3 area and make it work for both formats." (Eakin, 2001)

While broadcasters such as the BBC have somewhat avoided this dilemma by broadcasting in the compromise 14:9 aspect ratio, necessitating only marginal letterboxing, American and most Australian broadcasters are reluctant to go down the unpopular letterbox path, even in 14:9. This has given rise to the doctrine of the '4:3 protect mode', creating content that works in both 4:3 and 16:9. However, this is proving problematic. Consider for example the problem posed by edit timing, a critical factor in many programs where edits are performed as characters enter and leave frames. Should an edit take place when the character enters the 16:9 frame, or the 4:3 frame? Cutting on the 16:9 frame will mean 4:3 viewers will not see the character enter the frame, while cutting on 4:3 will present the character's entrance too early for 16:9 viewers. A significant problem for comedic and action timing (Dark, qtd in "Birkmaier and Pescatore", 2000, chapter 4). Similar problems are encountered with logos and animated graphics, should they be optimised for 4:3, at risk of looking awkward and poorly timed in 16:9? While broadcasters attempt to convince content makers to 'shoot and protect' for 4:3, the BBC decision to broadcast a letterboxed 14:9 seems sensible.

Moreover, while all new production in Australia is commissioned in 16:9, and the old 4:3 aspect ratio will die when the analogue signal is switched off in 2008, it is disturbing that 4:3 is still one of the available formats within the American DTV standard. Considering that the US is an important program export market, Australian and European producers will still have to contend with the 4:3 demon for some time to come.

A final word on 16:9 acquisition. Shooting 16:9 can be acquired a number of ways, though some methods should be avoided. 16:9 can be acquired directly through a 16:9 acquisition format, such as film, HDCAM or some of the switchable digital formats. In the case of the switchable format cameras, it is important to use a camera that possess a 16:9 CCD chip, which simply produces 4:3 by placing pillarboxes on the sides. The most inappropriate are cameras that 'fake' 16:9 by stretching or letterboxing the 4:3 chip. This results in a diminished line resolution of only 432 actives lines instead of 576 in 625 PAL (Wilt, 2002). The same poor result is reached by soft matting 16:9 on a 4:3 image during post production. Given that full 576 line PAL is unlikely to survive the transition to HDTV, an even more degraded version of S-VHS like 432 lines should be avoided.

Despite the problems inherent in the transition to widescreen television, both Europe and Australia are pushing ahead with 16:9 transmission. The UK, the first country in the world to begin DTV, is already completely committed to widescreen, in fact, to the extent that it is virtually impossible to purchase a 4:3 television set. The remainder of Europe is moving to 16:9, though more slowly. In Australia, approximately 50% of primetime evening programming is widescreen, as is all new programming, most local news and sports coverage, along with first run movies. Moreover, sales of widescreen television sets are beginning to take off in Australia, with sales increasing 700% from 2001 to 2002, at an average cost of $1600 (DBA, 2002). And despite the inclusion of the 4:3 ratio in the American DTV standard, all the other formats in standard, including HDTV, are 16:9 formats. Therefore, all American content creation will shift to 16:9 production over the long term.

2.5.3 Sound

Digital television will bring with it dramatically improved audio quality, based on two internationally recognised audio encoding systems. Initially, the European DVB system was based on MPEG 1, Layer II (stereo), while the American ATSC system was based on the more sophisticated surround sound Dolby Digital AC-3. DVB's adoption of MPEG 1, Layer II audio was based on its widespread use within radio broadcasting, DVD, consumer electronics equipment, multimedia and cable and satellite broadcasting. In short, it is a robust system that has widespread industry and consumer acceptance.

However, the Americans, with their focus on the cinema quality HDTV experience, pushed the envelope to adopt Dolby Digital 5.1 Surround Sound, a system based on cinema quality sound. With surround sound, six separate channels of audio are decoded by the receiver and sent to six different speakers, this includes a Front speaker, Left and Right Front speakers, Left and Right Rear speakers, and a Subwoofer. Combined with high definition resolution images, true surround sound makes for a powerful viewing experience. As a consequence of Australia's embrace of HDTV and Dolby Digital, AC-3 was subsequently accepted within the DVB international standard. Australian broadcasters have the choice of broadcasting in MPEG 1, Layer II stereo or Dolby Digital Surround Sound. The likely outcome is for broadcasters to transmit movies and other high quality presentations in surround sound, while transmitting MPEG Audio for other less cinematic programs. It should be noted that it is also possible to broadcast surround sound within the MPEG specification, known as Dolby ProLogic, however, this standard has failed to gain widespread acceptance. Essentially broadcasters have a choice of three audio formats, MPEG stereo, MPEG with Dolby ProLogic surround sound, as well as Dolby Digital 5.1 AC-3 surround sound.

2.5.4 Multiview

Not to be confused with 'multi-channeling', multiview is essentially a number of different camera angles, multiplexed and broadcast as separate channels within a given broadcaster's 7 MHz spectrum. It is sporting events that lend themselves ideally to this kind of digital broadcasting, allowing the viewer to select different camera angles via the remote control, similar to flicking between ordinary channels. To view the multiple camera angles within a single screen requires a receiver with PIP (Picture in Picture) capability.

Multiview is destined to be a popular viewer option, providing that broadcasters are willing to offer the necessary bandwidth required by the additional camera angle channels, although there is the possibility of offering secondary camera views at lower than SDTV resolutions. Essentially, broadcasters will choose whether to broadcast one HDTV signal of a sporting event, or multiple lower resolution camera angles, or even completely different content on any spare bandwidth. The final question is whether, beyond the novelty factor, viewers actually want to select their own camera views, considering that professional directors have performed this function since the beginning of television. Moreover, it is entirely possible that audiences may respond more enthusiastically to single stream HDTV content.

A number of sporting events are already being multiviewed, including the 2001 FAI 1000 Bathurst, the Melbourne Cup Carnival and the Sydney to Hobart Yacht Race [Crane, 2001).

2.5.5 Closed Captioning

To assist the hearing impaired, closed captioning is the provision of ‘on screen’ captions or subtitles. According to Australian Government legislation, broadcasters must, as far as practicable, provide captions for programs transmitted during primetime hours (6pm – 10:30pm). The same applies for television news and current affairs broadcast outside those times. In the UK, the principal commercial networks are expected to increase captioned programming to 80% by 2004, while the US has adopted a gradual phase in of 5 hours a day in 2002, 10 hours in 2003, 15 hours in 2004, and 20 hours in 2006 (DCITA review, 2000).

While governments around the world seek to improve the viewing experience for the hearing impaired, broadcasters, already buckling under the cost of the digital transition, are seeking captioning exemptions. Among others, Prime Television has claimed the cost of captioning its nine local news bulletins to be approximately $700,000 in equipment, followed by $800,000 per annum in salary costs (Ibid.). The costs are greater for live unscripted programs, such as sporting events. The ABC claims a cost of $942 per television hour of stenocaptioning services (Ibid.).

2.5.6 Multi-channeling

Multi-channeling is the broadcasting of more than one separate television program within the 7 MHz transmission spectrum. As a broadcaster has 19.35 Mbps in which to broadcast ‘data’, it is theoretically possible for one broadcaster to transmit four or five entirely separate television programs simultaneously. While this type of multi-channeling dominates digital television in the United Kingdom and Europe, and is permitted in the US, although the FCC is leaning heavily on broadcasters to provide HDTV, it was expressly forbidden under Australia’s digital broadcasting legislation until the advent of the Broadcasting Services Amendment (Digital Television and Datacasting) Act 2000 (Broadcasting Services Act, 1992/2000).

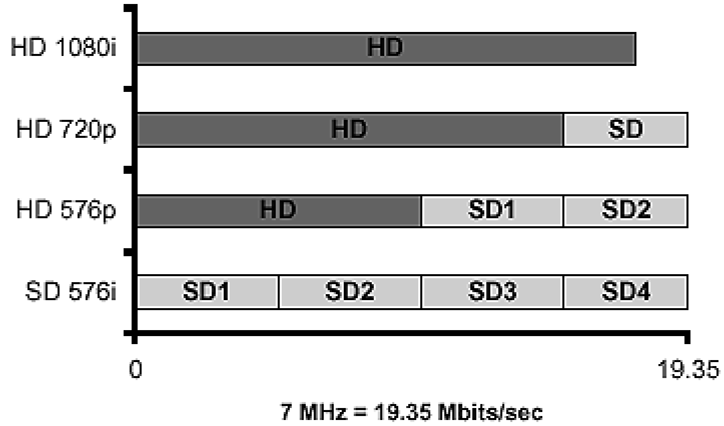

Figure 2.2: Transmission options within total bandwidth

[Update 5/5/03. Note: While the total data rate of digital television in Australia is often defined as 19.35 Mbps (American ATSC bit rate is19.39), the DVB system allows for variations in the total bit rate, a trade off in bit rate versus signal robustness. While the SEVEN Network and SBS are transmitting, or intend to transmit, at 19.35 Mbps, the NINE and TEN Networks, along with the ABC, have opted for a total data rate of 23Mbps. The higher data rate will result in slightly reduced signal coverage.]

This amendment allows the national broadcasters, government owned SBS and ABC, to multi-channel certain types of programs, while still barring the commercial free to air (FTA) networks from doing so. The ABC and SBS successfully argued that multi-channeling would assist them in meeting their responsibilities to the Australian public, as set out in their respective charters. In the case of the much larger ABC, this included provisions to,

> "…provide an information stream and a learning stream of programming….The information stream could include live coverage of events, repeats of current affairs programs, interviews and datacasting. The learning stream could include accredited educational courses and documentaries of an educational nature."
> (qtd in "DCITA Review National Broadcaster", 1999)

The Australian Subscription Television and Radio Association (ASTRA), the body representing Pay TV, argued that multi-channeling should not be permitted on any FTA stations, on the grounds that, "Pay TV currently provides a diversity and depth of entertainment and information services…..the types of programming which the national broadcasters are proposing to offer are already provided by subscription television." (Richards, 1999). Closer analysis would suggest that the Pay TV industry is less concerned about actual competition from the national broadcasters, and more concerned about the prospect of future multi-channeling by the commercial FTA's.

Predictably, the Federation of Australian Commercial Television Stations (FACTS) argued that any provision for the national broadcasters to multi-channel should be limited to programs that are not provided by the commercial broadcasters, thus reducing competition (Branigan, 1999). In the end, the final Digital Amendment Bill reflected that viewpoint, allowing the ABC and SBS to multi-channel, but only educational, regional news and current affairs, children's programming, as well as arts and sciences.

2.6 Implications of Multi-channeling

While the current debate in Australia about the merits of multi-channeling is couched in terms of 'viewer choice' and 'viewer control', it is also possible to interpret it as a struggle between choice and fragmentation on one side; quality and consolidation on the other. Both sides of the equation have their supporters, usually based on the needs of their own business objectives. It is also a debate overshadowed by the issue of broadcast liberalisation, specifically the entry of a number of new players into Australia's television broadcasting space. These include a range of non-television media interests, from leading newspaper publishers, Fairfax and News Limited, to telecommunications and Internet companies, all of which have demonstrated an interest in securing television broadcast spectrum. As far as these interests are concerned, multi-channel enabled 'viewer choice' can also be seen as a Trojan Horse in dismantling the dominance of Australia's three commercial free to air broadcasters. Interestingly, one of these broadcasters, the SEVEN Network, is now also arguing for multi-channel broadcasting, presumably on the grounds that multiple sports programming will generate additional revenue.

2.6.1 Viewer Fragmentation

It is here that it is necessary to examine whether the kind of market fragmentation that multi-channeling engenders, constitutes a viable business model for commercial broadcasters, as well as their advertisers. Although it may seem contrary to its own interests, FACTS has continued to oppose the adoption of multi-channeling on the commercial FTA's, based largely on the viewpoint that it is an unproven business model. FACTS made the following salient points,

> "The public interest assessment should look to quality of current services as well as quantity of services available. FACTS research has indicated that consumers are more interested in better quality services, rather than more services per se."

> "In assessing the public benefits of providing more services to viewers, it is important to take into account the effect competing services may have on the quality of existing commercial services. If viewers are drawn to competing news services,

> for example, this will impact on revenue, and may lead to programming cuts which will affect the quality and local content of programming." (Ibid.)

The reference here is not only to the potential appeal of HDTV programming, but also to the dangers of spreading content too thin, potentially resulting in more fragmented audiences and diminished advertising revenues. Some advertisers, however, refute the 'fixed pie' advertising revenue concept implicit in the FACTS statement, claiming that advertising spending will grow as advertisers find new ways to reach targeted consumers. In a submission to the Productivity Commission's Broadcasting Inquiry, the Australian Association of National Advertisers argued that,

> "[A]dvertisers will increasingly get more sophisticated in their targeting. In its crudest sense advertisers try to reach a particular audience and each product or service differs in relation to the sort of audience that they're seeking to reach. … if that audience becomes fragmented … then that will enable advertisers to be more focused in how they find that audience. (trans., p. 1129)" (Productivity Commission, 2000)

The advertising body went on to argue that multi-channeling would enable advertisers to access more cost effective ways of reaching their target audience, a proposition supported by the Productivity Commission. The Commission did indeed accept the notion of fragmentation, but differed in its conclusion,

> "Fragmentation will continue to occur regardless of the number of free to air commercial broadcasting services. But allowing commercial free to air television broadcasters to multi-channel (as recommended by this report) will allow them to target audiences better, and to draw some benefit from this fragmentation." (Ibid.)

However, the Commission did concede that the threat of fragmentation was a greater threat to FTA broadcasters than other media, as they are primarily dependant on attracting a large, broad audience, stating that, "As other forms of media become more effective at targeting specific groups that advertisers wish to reach, free to air mass broadcasting could be become relatively less effective." (Ibid.) This is a curious admission from the Productivity Commission, essentially an admission that the kind of fragmentation encouraged by multi-channeling is in fact detrimental to the viability of commercial free to airs. However, in the interests of media deregulation, it is the Commission's opinion that any risk to the FTA's is worth taking. The FTA's content that better quality pictures translate into better advertising opportunities for advertisers, an argument that is highlighted by the Commission's own reference to a digital television paper presented by Balnaves and Varan, in which it was stated,

> “Advertisers, at least on premium accounts, have demonstrated that they are willing to pay to insure that their product reflects high production values. This is not only a result of their need to display the product and brand as clearly as possible, but is supported by strategic research demonstrating that high production values result in higher recall and purchase intent … Hence there is a strategic justification for higher production value despite marginal additional cost.” (qtd in “Productivity Commission, 2000, p. 191)

This would seem to support the viewpoint of FACTS, that higher production standards, in this case HDTV, will result in larger audiences, and hence better advertising reach. While it is evident that FACTS is certainly interested in protecting its market position, the author believes that the extreme high cost of operating a television station, along with exorbitant cost of producing high quality content, does in fact require a certain level of market consolidation. Good programming costs money, and somewhere along the line someone has to pay for it. The recent collapse of ITV Digital in the United Kingdom, due largely to the cost of supporting premium multi-channel sporting content, is salient example. It should also be noted that Australia’s FTA broadcasters have proven themselves over four decades, providing the nation with relatively high quality programming, and at a profit. It remains to be seen whether the collection of aspiring broadcasters can deliver over the long term, given that their business models are unproved. This is an issue that affects not only the broadcasting industry, but also Australia’s film and television industry, an industry dependent on a consistent and stable flow of capital funding. It is for this reason that the Screen Producers of Australia Association (SPAA), quite possibly the only neutral observer in this debate, questioned the viability of the national broadcasters multi-channeling without extra funding,

> “While multi-channeling represents a useful extension to the services offered by the national broadcasters, it is imperative that the shift to multchanneling is adequately funded. Without a reasonable commitment to the costs involved in providing additional services, multi-channeling would be able to offer little that was interesting or be an effective extension of the national broadcaster’s role.” (Herd, 1999)

Perhaps the most appropriate method of evaluating the impact of multi-channeling on viewer fragmentation is to examine it in the field, namely the United Kingdom and Europe where such a broadcasting environment has been openly fostered. With a 30% digital television take up rate, the United Kingdom is often cited as proof of the viability of multi-channeling (Mori, 2001). However, a rapid take up rate does not necessarily translate into a viable business model, as recent financial data indicates. Of the four main multi-channel networks operating in the UK, one has failed, while the remaining three continue to incur significant losses. Even British Sky Broadcasting, the largest multi-channel broadcaster with 5.7 million subscribers, in May 2002 announced a quarterly loss of 30.8 million pounds, the twelfth in succession (Financial Post, 2002). Moreover, the collapse of ITV Digital has rocked the foundations of Britain’s digital broadcasting industry, to the extent that CEO of Channel 4, and former BSkyB director of programming, David Elstein, recently declared Britain's digital television "a disaster" and "a license to lose money" (Hodgson, 2002), also adding the following comment, "NTL is virtually broke. Sky has lost 1bn (pounds), ITV Digital has lost 1bn. If this is competition, then please bring back monopoly" (Ibid.). The fallout likely to set back Britain's roll out of DTV and necessitate a re-evaluation of the business models unpinning the industry.

Across the channel, DTV multi-channeling has also proved problematic, with the failure of Spain's DTV multi-channel regime prompting the Spanish Government to abandon the conversion to digital. Even Austar, Australia's leading digital satellite broadcaster, continues to incur significant losses, including a $682 million Australian dollar loss for the year 2001 (Fraser, 2002). Collectively, these poor results indicate a fundamental flaw in the business models of multi-channel broadcasting, indicating that content quality is perhaps more important than viewer choice.

[Update 5/5/03. Austar remains in financial trouble; $400 million in debt, its shares trading at about 25 cents, down from a high of $9.60 two years ago. In the U.K., cable company Telewest continues to struggle, recording a 2.2 billion pound loss for 2002, compared with a 1.9 billion pound loss in 2001. Debt now stands at 5.3 billion pounds (Daily Mail, 2003). The other embattled pay TV cable company, NTL, also continues to incur significant losses, recording an annual loss of 1.5 billion pounds in 2002 (Daily Mail, April 2004). BSkyB, with its 6.3 million subscribers in the UK, seems to have stemmed the string of losses to record its highest half yearly operating profit of 158 million pounds to December 31st 2002 (Swedlow, Feb, 2003). However, the company carries significant debt, incurred during the upgrade to digital. BSkyB penetration is partly attributable to the company's strategy of giving away millions of 200 Pound digital set top boxes. The Economist magazine also attributed Sky's success to obtaining exclusive premium content, such as live premiership football from free to air TV, as well as effective marketing and sales techniques, in particular, the bundling of premium channels to extract maximum dollar from the subscriber. As Tony Ball, BSkyB's CEO expressed it, "You've got to be careful how much money you take off a subscriber. The trick is to know just how far to fleece consumers without losing them (Economist, 2003).

After the collapse of ITV Digital, Britain re-launched digital terrestrial television in October 2002. Called Freeview, it is a free-to-air multi-channel network backed by the BBC, BSkyB and transmission company Castle Crown. While over 1.4 million households are already receiving Freeview, much of this early success is attributable to the existence of approximately 1 million former ITV Digital set-top boxes in TV households. It will be interesting to see how many more TV households are prepared to purchase a digital terrestrial set-top box. In fact, in April 2003, BARB Audience Research indicated that Freeview households were only watching the network 20% of the time, while the remaining 80% of viewing was spent on the UK's five terrestrial analogue channels (Swedlow, April, 2003). However, given that Freeview is barely six months old, even a 20% viewing rate is promising.

A 2001 study on subscriber churn by Nielsen Media indicated that viewers want more than simply extra channels, in fact, in cases where viewers had 100 channels at their disposal, they only watched about 16 of them (McMahon/Flanagan, 2001). This suggests that consumers value choice to a certain point, beyond which they value higher quality content or even interactive services.

In January 2003, the Spanish Government asked electronic manufacturers and broadcasters to work together to resurrect the country's failed DTT roll-out. The Government plans provide existing broadcasters with the 14 channels previously assigned to the failed Quiero DTT platform, with new digital terrestrial legislation expected soon. Interestingly, the Spanish Government has asked broadcasters to offer "specific programming different from that in analogue" (DTV Group, 2003). This would seem to suggest that standard multi-channel programming is less than appealing to Spanish audiences.]